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(54) SOLID-STATE IMAGE PICKUP DEVICE, SIGNAL DETECTION DEVICE AND SIGNAL ACCUMULATION DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To select/non-select a picture element, to eliminate the need of a selection switch and a selection switch line and to reduce a picture element size, by changing the operation point of an input terminal in a signal amplifier part which signal-amplifies a light charge from a photodiode.

SOLUTION: A charge generated by light is accumulated in the photodiode 5. A reset operation is executed by inputting prescribed voltage to the input terminal of the signal amplifier part 3 with a transistor Q2. Then, a transfer switch Q1 is opened/closed and the signal charge is transferred to the input terminal of the signal amplifier part 3. At that time, the transfer switch Q1 directly and electrically connects the photodiode 5 and the input terminal of the signal amplifier part 3. The output signal of the signal amplifier part 3 immediately after the reset operation is kept and it is subtracted from the output of the signal amplifier part 3 after the signal charge is transferred. Thus, a noise

component is removed.

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CLAIMS

[Claim(s)]

[Claim 1] In the solid state camera possessing a means to make sequential selection of the signal from two or more photo detectors and these photo detectors which were arranged by two-dimensional on the same semi-conductor substrate, and to output outside The signal amplifier which carries out signal magnification of the photoelectrical load from photo diode and photo diode at least into a pixel, The solid state camera characterized by controlling the read-out gestalt of a signal by having the device in which the electrical potential difference of arbitration is inputted into the input terminal of the charge transfer section which transmits a photoelectrical load to said signal amplifier from said photo diode, and said signal amplifier, and changing the operating point of the input terminal of said signal amplifier.

[Claim 2] It is the solid state camera characterized by said input terminal being the gate of said MOS transistor by said signal amplifier

consisting of an MOS transistor in a solid state camera according to claim 1.
[Claim 3] The solid state camera characterized by said signal amplifier consisting of a junction type transistor in a solid state camera according to claim 1.
[Claim 4] The solid state camera characterized by said signal amplifier being a follower format in a solid state camera according to claim 1.
[Claim 5] The solid state camera characterized by said signal amplifier being an addition format in a solid state camera according to claim 1.
[Claim 6] It is the solid state camera which consists of a transistor by which said charge transfer section was inserted between said photo diodes and input terminals of said signal amplifier, controls read-out of a signal by changing the operating point of the input terminal of said signal amplifier in a solid state camera according to claim 1, and is characterized by impressing an electrical potential difference to the photo diode of said transistor, and the terminal of the opposite side during a non-read-out period.
[Claim 7] The solid state camera characterized by the device in which the electrical potential difference of arbitration is inputted into the input terminal of said signal amplifier consisting of an input terminal of said signal amplifier, and a switching device prepared between output terminals in a solid state camera according to claim 1.
[Claim 8] The solid state camera characterized by controlling the format of said signal amplifier of operation by controlling the polarity of the power-source line connected to said signal amplifier in a solid state camera according to claim 2.
[Claim 9] The solid state camera characterized by controlling the format of said signal amplifier of operation by controlling the polarity of the power-source line connected to said signal amplifier in a solid state camera according to claim 3.
[Claim 10] In the signal detection equipment possessing a means to make sequential selection of the signal from two or more signal sensing elements and these signal sensing elements which were arranged by two-dimensional on the same semi-conductor substrate, and to output outside The signal amplifier which carries out signal magnification of the signal charge from said sensing element and said sensing element at least into a cel, Signal detection equipment characterized by controlling the read-out gestalt of a signal by having the device in which the electrical potential difference of arbitration is inputted into the input terminal of the charge transfer section which transmits a signal charge to this signal amplifier, and said signal amplifier, and

changing the operating point of the input terminal of said signal amplifier.
[Claim 11] In the signal are recording equipment possessing a means to make sequential selection of the signal from two or more signal are recording components arranged by two-dimensional on the same semi-conductor substrate, and this signal are recording component, and to output outside The signal amplifier which carries out signal magnification of the signal charge from said signal are recording component and said signal are recording component at least into a cel, Signal are recording equipment characterized by controlling the read-out gestalt of a signal by having the device in which the electrical potential difference of arbitration is inputted into the input terminal of the charge transfer section which transmits a signal charge to this signal amplifier, and said signal amplifier, and changing the operating point of the input terminal of said signal amplifier.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a solid state camera, signal detection equipment, the solid state camera that has in detail the signal amplifier which changes the operating point of an input terminal for every pixel about signal are recording equipment, signal detection equipment, and signal are recording equipment.
[0002]
[Description of the Prior Art] The representative circuit schematic of the picture element part of the conventional two-dimensional solid state camera is shown in drawing 16 (a) and (b). the inside of drawing 16 -- respectively -- 1 -- in a power-source line and 2, a signal output line and 5 show photo diode, and, as for a reset switch line and 3, 6 shows a transfer switch line, as for a selecting-switch line and 4. drawing 16 (a) -- for example, IEDM in 1993 -- setting -- Mr. Eric R.Fossum -- ** -- it is the circuit of the solid state camera reported (technical sample 1:IEDM93-583-586). Moreover, drawing 16 (b) is the circuit of the solid state camera reported by "ISSCC96/Session1 / Plenary Session/Paper TA1.2." Drawing 17 is the example which added the readout circuitry which arranges the pixel of drawing 16 (b) to two-dimensional, and reads

a picture signal.
[0003] Thus, in a two-dimensional solid state image sensor with a signal amplifier, the component which constitutes two or more switching devices and signal amplifiers in addition to photo diode is required in each pixel. In drawing 16 (a), since per pixel, photo diode, and no less than four MOS transistors are needed, the size which is surely 1 pixel will become large.
[0004] Fundamental actuation of drawing 16 (a) and drawing 17 is explained.
** Perform line selection by the reset action and selecting switch Q4 which input a reset electrical potential difference into the input node of a source follower Q3 by the reset switch Q2.
** Make the input node of a source follower Q3 into floating, read the noise component which consists of fixed pattern noises, such as a reset noise and threshold voltage variation of a source follower MOSQ3, and once hold the information in the signal are recording section 15.
** After that, the transfer switch Q1 is opened and closed, transmit the stored charge generated by the lightwave signal to the input node of a source follower Q3, read the sum of the above-mentioned noise component and a lightwave signal component, and hold in the signal are recording section 15.
** Read the signal of the signal of a noise component, a noise component, and a lightwave signal component to the common signal line 19 and 19' through the transfer switch 18 to a common signal line, and 18', respectively. The output of the common signal line 19 and 19' has obtained outputs 13 and 14 through buffer amplifier, respectively. Outputs 13 and 14 are the latter part, and a reset noise and a fixed pattern noise can be removed by taking both difference. In addition, read-out of each pixel is sequentially scanned with the perpendicular shift register 12 and the level shift register 16.
[0005]
[Problem(s) to be Solved by the Invention] On the other hand, although per pixel, photo diode, and three MOS transistors are needed, drawing 16 (b) has few one transistors, ends, and becomes unnecessary [a transfer switch line] from drawing 16 (a) in connection with this. This is very important, when making pixel size small.
[0006] However, since there is no device in which the noise component of each pixel is held during the are recording period since there is no transfer switch in the pixel of drawing 16 (b), noise rejection will not be able to be carried out but it will become a solid state camera inferior to the case where the S/N ratio which is a ratio of a signal

component/noise component is drawing 16 (a).
[0007] As stated above, in the Prior art, it was difficult to have a high S/N ratio and to carry out contraction-ization of pixel size.
[0008]
[Means for Solving the Problem] This invention has the reset mechanism which inputs the electrical potential difference of arbitration into the input terminal of the signal amplifier which carries out signal magnification of the photoelectrical load from photo diode and photo diode at least into a pixel, the charge transfer section which transmits a photoelectrical load at this signal amplifier, and a signal amplifier, and solves the above-mentioned trouble by being carried out when selection and un-choosing change the operating point of the input terminal of a signal amplifier. [of a pixel]
[0009] According to this invention, it can perform selection and un-choosing by changing the operating point of the input terminal of said signal amplifier, consequently the following effectiveness can be acquired. [of a read-out pixel]
[0010] It becomes possible to lose the need of forming the selecting switch and selecting-switch line which were the need conventionally, and to reduce pixel size.
[0011] By making a selecting switch unnecessary, property degradation of a fall of non-linearity or a dynamic range which had arisen by the voltage drop of a selecting switch conventionally can be lost.
[0012] Furthermore, this invention is set to the solid state camera possessing a means to make sequential selection of the signal from two or more photo detectors and these photo detectors which were arranged by two-dimensional on the same semi-conductor substrate, and to output outside. The signal amplifier which carries out signal magnification of the photoelectrical load from photo diode and photo diode at least into a pixel, It has the device in which the electrical potential difference of arbitration is inputted into the input terminal of the charge transfer section which transmits a photoelectrical load to said signal amplifier from said photo diode, and said signal amplifier, and is characterized by controlling the read-out gestalt of a signal by changing the operating point of the input terminal of said signal amplifier.
[0013] Moreover, in the above-mentioned solid state camera, it consists of a transistor by which said charge transfer section was inserted between said photo diodes and input terminals of said signal amplifier, read-out of a signal is controlled by changing the operating point of the input terminal of said signal amplifier, and it is characterized by

impressing an electrical potential difference to the photo diode of said transistor, and the terminal of the opposite side during a non-read-out period.

[0014] Moreover, this invention is set to the signal detection equipment possessing a means to make sequential selection of the signal from two or more signal sensing elements and these signal sensing elements which were arranged by two-dimensional on the same semi-conductor substrate, and to output outside. The signal amplifier which carries out signal magnification of the signal charge from said sensing element and said sensing element at least into a cel, It has the device in which the electrical potential difference of arbitration is inputted into the input terminal of the charge transfer section which transmits a signal charge to this signal amplifier, and said signal amplifier, and is characterized by controlling the read-out gestalt of a signal by changing the operating point of the input terminal of said signal amplifier.

[0015] Furthermore, this invention is set to the signal are recording equipment possessing a means to make sequential selection of the signal from two or more signal are recording components arranged by two-dimensional on the same semi-conductor substrate, and this signal are recording component, and to output outside. The signal amplifier which carries out signal magnification of the signal charge from said signal are recording component and said signal are recording component at least into a cel, It has the device in which the electrical potential difference of arbitration is inputted into the input terminal of the charge transfer section which transmits a signal charge to this signal amplifier, and said signal amplifier, and is characterized by controlling the read-out gestalt of a signal by changing the operating point of the input terminal of said signal amplifier.

[0016]

[Embodiment of the Invention] Drawing 1 (a) shows the equal circuit of 1 pixel which expressed the description of this invention best. Moreover, drawing 1 (b) shows the mimetic diagram for explaining the example of read-out of this invention. The principle of this invention is explained using these drawings.

[0017] In drawing 1 (a), the charge generated by light to photo diode 5 is accumulated. A predetermined electrical potential difference is inputted for the input terminal of the signal amplifier 3 with a transistor Q2. Henceforth, this actuation is called a reset action. Then, the transfer switch Q1 is opened and closed and a signal is transmitted for a signal charge to the input terminal of the signal amplifier 3.

Here, although it is a means to transmit a signal charge, the input terminal of the signal amplifier 3 may be connected with photo diode 5 directly electrically like the transfer switch Q1. Moreover, the connection transistor may be connected not only with one but with two or more transistors. Furthermore, you may consist of one or more steps of shift registers of a charge coupling mold. Namely, this invention is not limited to a charge transfer means, and just transmits signaling information to the input terminal of the signal amplifier 3 by the approach of kana in any way.

[0018] At this time, a noise component is removable from the output of the signal amplifier 3 after holding the output signal of the signal amplifier 3 immediately after a reset action and transmitting a signal charge by deducting. After embedding especially the photo diode 5, making it the photo diode of a mold and transmitting a signal charge, various random noise produced by the reset action is also removable making the are recording field of photo diode 5 fully depletion-ize by performing a design which becomes about 1-10 electrons about the number of residual charge.

[0019] Drawing 1 (b) is drawing by which the signal amplifiers 31-34 for every pixel are connected to the common signal output line 7 in a certain train among each pixel arranged in the shape of two-dimensional. Fundamentally, the signal amplifier 3 is a part including the input of the signal amplifying device of many inputs, and shows the load by the load 36 of a signal amplifier connected between power sources 8. In order to operate the signal amplifiers 31-34 by the source follower method for this load, a constant current source may be used between the glands of a reference potential point. However, depending on the purpose, it may be formed by one element, and may be formed by two or more elements. In this invention, it is important that it is the signal amplifying circuit 3 where the signal amplifying device which the signal amplifier 3 constitutes is represented in a comparator circuit or an adder circuit and in which many inputs are possible. The load 36 of the signal amplifier 3 in drawing is based on the format of the signal amplifying device which the signal amplifier 3 constitutes of operation. For example, if it is the follower format that a signal amplifying device is represented by the below-mentioned example 1, it will become a constant current source and a power source 8 will serve as a gland. Moreover, if it is a reversal amplifier format by resistance load with which a signal amplifying device is represented by the below-mentioned example 2, the load 36 of the signal amplifiers 31-34 will be resistance, and a power source 8 will serve as supply voltage VDD.

[0020] The principle of operation is explained below. For example, in the follower format that a signal amplifying device is represented by the example 1, if there is no switch for line selection, the output of a signal amplifying device will turn into an output of the line which shows the high output of an electrical potential difference most. Therefore, when reading a lightwave signal in the pixel configuration to which an output becomes low as a lightwave signal becomes large, read-out of a line made into the purpose will not be able to be performed, but the dark level of one of lines will be outputted. In the Prior art, the selecting switch was formed as a means to avoid this. On the other hand, in the input terminal of the signal amplifier of the line which does not read when reading in this invention, the electrical potential difference which the transistor of a source follower turns off is inputted, if the electrical potential difference to turn on is inputted into the input terminal of the signal amplifier of the line which reads, only a read-out line will serve as activity and the output of the line which inputted ON electrical potential difference into the output terminal 7 of a signal amplifier will appear. By the following approaches, signal read-out removable to random noise becomes possible.

[0021] Although it was expressed as "the electrical potential difference to turn off" by the above-mentioned, if it aims only at selection of a read-out line, it is not necessary to turn off completely. For example, if 2volt(s) are inputted into a non-choosing line when inputting 5.0volt(s) as an ON electrical potential difference at the time of supply voltage being 5.0volt(s), reading and choosing Although an input transistor does not carry out OFF completely, if the input voltage of a selection line is 2 or more volts, the signal of a selection line will be outputted to the output terminal 7 of signal magnification, and if the input voltage of a selection line is 2 or less volts, the signal whose input voltage is an equivalent for 2volt(s) will be outputted to the output terminal 7 of signal magnification. By this approach, a limit can also be applied to a saturation power electrical potential difference.

[0022] The example of the approach of reading to below is given. In the following examples, it becomes possible to remove to the random noise produced in connection with a reset action.

** Input the OFF electrical potential difference through the transistor Q2 after signal read-out.

** In order to read a selection line, input ON electrical potential difference into the input terminal which was a former OFF electrical potential difference through a transistor Q2.

[0023] Consequently, the signal amplifier 3 of a selection line serves as activity.
** turn off a transistor Q2 and hold the output of the signal amplifying device which consists of a fixed pattern noise and random noise of an input terminal into the part equivalent to the signal are recording section 15 of drawing 17 .
** Open and close the transfer switch Q1 and transmit the signal charge accumulated in photo diode 5 to the input terminal of the signal amplifier 3.
The output of the signal amplifying device with which the signal charge was added to the noise signal of **** is held into the part equivalent to the signal are recording section 15 of drawing 17 .
** Input an OFF electrical potential difference into the input terminal of the signal amplifier 3 through a transistor Q2, and make the signal amplifier 3 of the line inactive, after reading a signal.
** Subtract the output signal which consists of a noise signal of ** from the output signal which consists of a noise signal + signal charge of ** currently held at the signal are recording section 15.
[0024] The subtraction approach can carry out thing activation using the difference circuit and capacity clamping circuit by the operational amplifier.
[0025] According to the process of above ** - **, a part for a noise signal can be removed and the high solid state camera of a S/N ratio can be realized.
[0026] This invention is not limited to the above-mentioned read-out approach, after it reads the output signal which consists of a noise signal + signal charge the sequence which a noise signal reads, it may perform a reset action, may read the output signal which consists of a noise signal, and may deduct it from the output signal which consists of a noise signal + signal charge. In this case, although the random noise by the reset action is unremovable, the removal of a fixed pattern noise which a signal amplifier has becomes possible.
[0027] In order to be able to exclude the selecting switch for outputting a pixel signal to the signal output line which was the need conventionally, consequently to be able to reduce an element number and to reduce pixel size by this invention, there is big effectiveness.
[0028] Next, another effectiveness of this invention is explained. In a solid state camera, although the linearity and the dynamic range of a signal amplifying device are required, when a selecting switch exists, there is also a trouble that linearity is spoiled by the resistance component of a selecting switch depending on operating range. For

example, in the field where the gate voltage of the MOS source follower Q3 is low, as shown in drawing 16 , when the selecting switch Q4 by the MOS transistor is inserted, since sufficient electrical potential difference VGS between the gate sources for a selecting switch Q4 is impressed, the current of a constant current source can be passed on the low electrical potential difference VDS between the drain sources, and the voltage drop in a selecting switch Q4 can be disregarded. On the other hand, in the field where the gate voltage of the MOS source follower Q3 is high, since VGS of a selecting switch Q4 becomes small, that much big VDS is needed, and since [in a selecting switch Q4] a voltage drop increases functionally the 2nd order, linearity is spoiled remarkably. Output voltage also becomes small and becomes the big factor of dynamic range degradation at it and coincidence.

[0029] In order to avoid such non-****, there is also a method of forming a selecting switch Q4 in the VDD side of the MOS source follower Q3, but since VGS of a selecting switch Q4 cannot be taken primarily, the voltage drop in a selecting switch Q4 will become large, and a dynamic range will deteriorate.

[0030] Qualitatively, the voltage drop V is shown by the following formulas.

[0031] The threshold voltage beta of the selecting switch MOSQ4 with which the current value Vth of the constant current source from which V=root(Iconst/beta)+VthIconst serves as a load of a source follower Q3 also included the substrate bias effectiveness is a structure parameter showing the driving force of a selecting switch Q4. Moreover, since the oxide-film capacity of MOS of the signal output line 4Q3 is added by all the line in this case, load-carrying capacity will become large and high-speed operation will become difficult.

[0032] In order to perform high-speed operation, it is necessary to enlarge Iconst but, and as the above-mentioned formula, if Iconst is enlarged, the voltage drop in a selecting switch Q4 will become large.

[0033] By this invention, the load of the oxide-film capacity is not carried out in inputting an OFF electrical potential difference into the MOS transistor which hits the MOS source follower Q3 of a non-choosing line. And since there is no selecting switch Q3, the solid state camera of a large dynamic range can be offered.

[0034] Moreover, this invention is not limited to the solid state camera which reads a lightwave signal, can use a magnetometric sensor for a signal sensing element, and can offer two-dimensional magnetic detection equipment.

[0035] Moreover, retention volume can be used instead of the photo diode

5 of drawing 1 (a), and analog memory can also be offered. For example, analog memory can be offered by reading the analog data which impressed the analog data to the reset power-source line, wrote the analog data in the above-mentioned retention volume through Q2 and Q1, and was written in retention volume in the same procedure as reading the above-mentioned lightwave signal. It designs so that 256 gradation, i.e., 8Bit digital data, may be written in 1 pixel as one analog data, and it arranges to 1 million pixels. Consequently, the analog memory of 8Mbit can also be offered.

[0036] In addition, in the above-mentioned operation gestalt, an MOS transistor which carries out source follower actuation, and an MOS transistor which carries out reversal magnification actuation of a resistance load were consisted of by the signal amplifier, and it is realized with small area and an easy configuration by semi-conductor process control in it.

[0037]

[Example] Hereafter, the example of this invention is explained based on the above-mentioned operation gestalt.

[0038] [Example 1] drawing 2 is the representative circuit schematic of the picture element part of this example. Drawing 3 is a circuit diagram for explaining this example also including a read-out system. The photo diode of an embedding mold as shown in drawing 4 was used for the photo diode of this example. The embedding photo diode which is a light sensing portion consists of an N type layer 603 formed in the WELL field 602 of the P type on the N type silicon substrate 601. The P type surface layer 604 formed on the N type layer 603 is a surface dark current prevention layer. Moreover, the insulating layer 607 is formed between the WELL field 602 of P type, and the gate electrode 606. The gate electrode 606 in drawing is a gate electrode of the transfer switch Q1 of drawing 2 , and connection of the N+ field 605 is carried out to the gate electrode of the source follower Q3 of drawing 2 . The end of the source follower Q3 of drawing 2 is connected to the signal output line 503 of drawing 3 , and through the signal output line 503, by connecting with a constant current source 513, a source follower Q3 forms a source follower, and is performing signal magnification. The transfer switch Q1 is a switch which transmits the charge accumulated in photo diode 405 to the gate of the source follower Q3 which hits the input terminal of a signal amplifier among drawing 2 . A reset switch Q2 is a switch for inputting the electrical potential difference set as the input terminal with the reset power source 402 among drawing 2 . In drawing 3 , read-out of a signal was performed for every line. an above-

mentioned operative condition -- it is shown like -- as -- a noise signal -- the beginning -- reading -- every component -- and it holds in the signal are recording section 506 constituted from capacitor capacity with which each object for noises and each lightwave signals were equipped. Next, a lightwave signal is read and it holds in the signal are recording section 506. After reading a noise signal and a lightwave signal to the signal are recording section 506, respectively, sequential closing motion of the switches QHnk and QHsk was carried out for each signal output currently held at the signal are recording section 506 with the level shift register, the noise signal and the lightwave signal were read to the common signal line 1 (509) and the common signal line 2 (510) one by one at the time series target, respectively, and the noise signal 511 and the lightwave signal 512 were outputted outside through the output amplifier 513. Then, subtraction processing of the noise signal = noise component from lightwave signal = [a Mitsunari part + noise component] was performed using two kinds of circuits, a clamping circuit and a differential circuit. Consequently, the signal could be read to the pixel, without arranging the pixel switch for line selection, and pixel size was able to be reduced, without deleting opening for the switch for selection. Moreover, about the S/N ratio, the S/N ratio equivalent to the conventional technique was able to be obtained.

[0039] The pulse timing to each transistor of a pixel used for this example is shown in drawing 6 . That is, it is a period until it reads a noise signal and a lightwave signal from a pixel to the signal are recording section 506.

[0040] Qn in drawing 6 , and Qs It is the write-in switch timing to the signal are recording section 506.

[0041] Moreover, drawing 5 is the input-output behavioral characteristics of a source follower used as a signal amplifier, Curves a are the input-output behavioral characteristics of this example, and input voltage A is a maximum input electrical potential difference. The input voltage C of a source follower is the minimum input voltage from which the linearity field is secured, and it designed so that it might grow into the electrical potential difference at the time of reading the maximum signal charge. Curve b is saturated from input voltage B, and is the narrow property of a dynamic range, the loss of a source follower circuit is large and Curve c is the property that gain is small, in absolute value.

[0042] The period D in drawing 6 is a selection period which is a pixel, and it checked that it could perform selection and un-choosing in the selection line in inputting the electrical potential difference more

than input voltage C into the input terminal of a source follower Q3, and inputting the electrical potential difference below input voltage C into a non-choosing line by the reset action. [of a line]
[0043] Sequential operation is explained referring to drawing 6 . After making a reset power source high-level, the reset switch Q2 of a line to choose is turned on. Consequently, the electrical potential difference of the gate of a source follower Q3 becomes high-level. if it is that become equal to a reset power source and the gate voltage of a source follower Q3 has the gate voltage of a reset switch Q2 comparable as a reset power source if the gate voltage of a reset switch Q2 of this gate voltage is a sufficiently high electrical potential difference compared with the electrical potential difference of a reset power source, or less than [it] -- the gate voltage of a reset switch Q2 -- a part for threshold voltage -- it becomes a low electrical potential difference.
[0044] After turning off a reset switch Q2 and making the gate of a source follower Q3 into floating, it is Qn of the transfer switch QHn to the common signal line 509. It turns on and the noise component immediately after reset is held in the signal are recording section 506 (the section A in drawing 6).
[0045] Since only the electrical potential difference of the gate of the source follower Q3 of a selection line is a sufficiently high electrical potential difference compared with the electrical potential difference of the gate of the source follower Q3 of a non-choosing line, as for the current by the constant current source arranged to the signal output line of each train, an electrical potential difference is outputted to the potential of the source follower Q3 gate of flow and a selection line from a source follower considerable the bottom only at the source follower Q3 of a selection line.
[0046] Next, Qn After turning off, the transfer switch Q1 is turned on and a lightwave signal component is transmitted to the gate of a source follower Q3 from photo diode 405 (the section B in drawing 6). Transmitted charge Qsig Voltage drop Qsig / [corresponding to capacity CQ3 of the gate terminal of a source follower Q3] CQ3 arises. OFF of the transfer switch Q2 holds the potential superimposed on the lightwave signal component by the noise component in the gate of a source follower Q3. An electrical potential difference is outputted to the electrical potential difference of the gate of this source follower Q3 from a source follower considerable the bottom.
[0047] At the gate of a source follower Q3, although the time of reading a saturation charge is the lowest electrical potential difference, in the selection reading method by the operating point of the gate of a

source follower Q3 that whose this electrical potential difference is high enough compared with the electrical potential difference of the gate of the source follower Q3 of other non-choosing lines it is this invention, it is important.

[0048] Next, it is Qs of the transfer switch QHs to the common signal line 510. And the signal which read the lightwave signal component on the noise component is held in the signal are recording section 506 (the section C in drawing 6).

[0049] Next, after making potential of a reset power source into a low level, a reset switch Q2 is made ON-OFF, the potential of the gate of a source follower Q3 is lowered, and it considers as the condition of not choosing.

[0050] Next, a dynamic range is explained using drawing 5 . In order to check the significance of this invention, the result at the time of performing line selection by the selecting switch Q4 using the conventional technique is also written together. Curves a, b, and c are characteristic curves in a pixel in case the pixel by this invention and the selecting switch Q4 are inserted between the power sources of input MOS transistor Q3, and the pixel shown in drawing 16 (a) of the conventional technique, respectively. In this example, the one where the input voltage of a source follower is higher is the Dark side, and the reset electrical potential difference of an input terminal is a power-source side by the reset switch Q2. The input voltage of a source follower declines as photoelectrical loads increase in number. Since it is the Dark side that a line type property is generally thought as important, it is necessary to secure linearity in the field where input voltage is high. By the pixel of the conventional technique, it was securable only to the electrical potential difference of B in drawing 5 to linearity having been securable to the electrical potential difference of A in drawing 5 in the pixel of this invention. From this, it was checked that the dynamic range of the pixel of this invention is large. In the field where especially supply voltage is low, this effectiveness showed up more notably and the minimum supply voltage which can operate operated to the low electrical potential difference about 1 volt as compared with the pixel shown in drawing 16 (a) of the conventional technique.

[0051] [Example 2] drawing 7 is the representative circuit schematic of the picture element part of this example. Drawing 8 is a circuit diagram for explaining this example also including a read-out system. The photo diode of an embedding mold was used for the photo diode 905 of this example like the 1st example.

[0052] It constitutes from reversal amplifier with which a signal amplifier consists of MOS transistor Q3 and load resistance 1014, and the pulse timing to each transistor of a read-out procedure or a pixel is the same as that of the 1st example.
[0053] That is, turned off MOS transistor Q3, once reset the gate terminal of MOS transistor Q3 of a selection line high-level, the current corresponding to the electrical potential difference of the gate terminal of MOS transistor Q3 of a selection line was read to load resistance 1014 by reading a lightwave signal to the gate terminal of MOS transistor Q3 in inputting the electrical potential difference below the threshold voltage of MOS transistor Q3 into the gate terminal of MOS transistor Q3 of a non-choosing line, and the lightwave signal was read to the sink and the selection target. The electrical potential difference same [the timing of read-out of a lightwave signal and a noise signal is the same as that of the 1st example, and] in order that the reset supply voltage impressed from a reset switch Q2 may take a large dynamic range as the 1st example is supplied.
[0054] Since the signal amplifier was reversal amplifier, the gain in a signal amplifier could be designed in circuit, and the high sensor of a S/N ratio was able to be offered to the source FOROWA amplifier in the 1st example.
[0055] The p channel junction field effect transistor was used for the transistor Q3 which constitutes the signal amplifier in [example 3] drawing 7 , and the photosensor constituted from reversal amplifier was produced from the load resistance for loads.
[0056] Since the gate electrode was formed from the impurity diffusion field, the junction field effect transistor Q3 has arranged the diffusion field which is a source drain field of the transfer switch Q1 as a gate electrode as it is. Consequently, since the contact section which connects metal wiring which consists of the field, i.e., the diffusion field, and the aluminum for connecting the gate electrode which consists of polycrystalline silicon of the diffusion field which is a source drain field of the transfer switch Q1, and a junction field effect transistor Q3 in the 1st and 2nd examples, the contact section which connect metal wiring with polycrystalline silicon, and the wiring section which connect the above-mentioned metal wiring became unnecessary, pixel size is reducible.
[0057] In this example, since the p channel junction field effect transistor Q3 was used, once having inputted into the non-choosing line the high level which is an OFF electrical potential difference and resetting to a selection line to abbreviation (1/2) *VDD which is ON

electrical potential difference, the lightwave signal was transmitted to the control electrode of a junction field effect transistor Q3. As a result of transmitting a lightwave signal to a control electrode, the electrical potential difference of a control electrode falls. Since supply voltage can also be lowered while lowering the electrical potential difference of this control electrode, there is no fall of a dynamic range and it can be made to operate with low supply voltage.

[0058] The representative circuit schematic of this example is shown in [example 4] drawing 9 . This example transposes the resistance load 1014 of a signal amplifier to MOS transistor 1114 in an example 2.

[0059] It is Vout about the output voltage outputted to Vin and the signal output line 1003 in the input voltage of a signal amplifier in an example 2. Then, Vout =R*A*(Vin-B)2R is A, and the resistance of a resistance load 1014 and B are the parameters of MOS transistor Q3 proper.

[0060] On the other hand, it is Vout about the output voltage outputted to Vin and the signal output line 1103 in the input voltage of a signal amplifier in this example. Then, Vout =A* (Vin-B)
A and B are the parameters of MOS transistor Q3 and load MOS1114 proper.

[0061] As mentioned above, output voltage Vout It could express as a primary function of input voltage Vin, and was able to be made A> 1. In this case, it is possible to make large the linearity field of the source follower Q3 of a signal amplifier.

[0062] The readout circuitry of this example is shown in [example 5] drawing 10 . The source terminal of MOS transistor Q3 of two or more pixels is connected to the signal output line 1206 like the above-mentioned example. The pulse timing to each transistor of a read-out procedure and a pixel is the same as that of the 1st example.

[0063] When the principle of operation impresses the fixed electrical potential difference VA to the VA terminal 1207, and the electrical potential difference between base emitters of this bipolar transistor is set to VBE, the emitter electrical potential difference of a bipolar transistor, i.e., the electrical potential difference of the signal output line 1206, is fixed to [VA-VBE].

[0064] It is the reset electrical potential difference Vres to the gate terminal of MOS transistor Q3. When inputted, the current I1 which flows to MOS transistor Q3 passes I1= {(Vres-Vth) -(VA-VBE)} / current I1 of r1.

[0065] Since I2= (VA-VBE) / current I2 of r2 flows in resistance r2, for the resistance r3 connected with the power source between bipolar transistors As for the current I3 which is [I2-I1], [(VA-VBE) /r2]-

{(Vres-Vth)-(VA-VBE)} / r1 flows. The electrical potential difference VB 1208 of Terminal VB VDD- [[(VA-VBE) *r3/r2]-[{(Vres-Vth) -(VA-VBE)} *r3/r1]]
It is given. if the electrical potential difference of the gate terminal of MOS transistor Q3 is set to Vres-deltaV as a result of transmitting a lightwave signal to the gate terminal of MOS transistor Q3 -- the electrical potential difference VB of a terminal VB 1208 -- VDD- [[(VA-VBE) *r3/r2]-[{(Vres-deltaV-Vth) -(VA-VBE)} *r3/r1]]
deltaV*r3 which is a lightwave signal component / r1 can be obtained by taking the difference of the electrical potential difference VB of the terminal VB 1208 after transmitting the electrical potential difference VB and lightwave signal of a terminal VB 1208 immediately after reset to the gate terminal of MOS transistor Q3.
[0066] Furthermore, in this example, the pulse shown in drawing 6 was impressed to coincidence to the multi-line, and the multi-line was changed into the selection condition at coincidence. Consequently, the addition result of a pixel signal was able to be obtained for Terminal VB by performing the above subtraction processings. Linearity addition cannot be obtained although it is possible to obtain an addition result also in examples 3 and 4. The addition result of the same color of two lines on the same level was made to specifically output to Terminal VB. Since there was un-****** switch resistance when there is a selecting switch like the conventional technique, the addition with precision was difficult, but since a selecting switch was not needed, it came to be able to perform easy and exact addition in this invention.
[0067] In the type of circuit of the [example 6] example 1, it impressed as the pulse timing to each transistor of a pixel was shown in drawing 11 . In this example, a reset switch is made into ON condition during a non-selection period, and it continued impressing the electrical potential difference of a reset power source through the reset switch Q2. Moreover, the transfer switch Q1 was set as the electrical potential difference between high level and a low level. Consequently, the broadside overflow-drain function in which overflow level is determined by the gate voltage of Q1 transistor was added, and the cross talk to a contiguity pixel was made to mitigate. Since overflow level is based also on the threshold voltage of Q1 transistor, it is possible for the gate voltage of Q1 transistor to also make it function as a broadside overflow drain also in 0volt depending on the threshold voltage of Q1 transistor.
[0068] Generally, the electrical potential difference by the side of the drain at this time is set as a high-level electrical potential

difference or its near, and it becomes indispensable [a selecting switch Q4] to operate the transfer switch Q1 as a broadside overflow drain, as shown in drawing 16 in this case. The source and the gate terminal of MOS transistor Q3 found out functioning as a broadside overflow drain, when this invention persons fulfilled the bias conditions from which Q1 transistor which the photo diode side used as the drain as a result of wholeheartedly examination serves as pentode actuation. The gate voltage of Q1 was lowered conventionally and the low level of a reset power source was set as 1.5volt(s) in this example. Furthermore, the limit of saturation voltage was applied with the electrical potential difference of this low level. The pulse timing to each transistor of the pixel shown in this example is not based on the type of circuit of an example 1, but can be adapted also in the type of circuit of other examples.

[0069] The type of circuit of each pixel of [example 7] this example is shown in drawing 12 . Drawing 13 is drawing having shown the pulse timing to each transistor of a pixel, and other main transistors, and the output voltage of the signal output line 1406. Moreover, the readout circuitry by this example is the same as that of the signal are recording section 506 and the level shift register 507 grade which are shown in drawing 3 . Then, as compared with the example 1 or the example 6, the reset power-source line was deleted and the reset electrical potential difference was impressed through the output signal line 1406. That is, the output-signal line 1406 performed the role of the output-signal line of examples 1 and 6, and a reset power-source line in time sharing by ON-OFF of Q4 transistor.

[0070] Like an example 1, it holds in the signal are recording section 506, and the signal from a pixel is once Switch QHn by the level shift register 507. QHs Sequential closing motion was carried out, the signal was read to the common signal line 1 (509) and the common signal line 2 (510) one by one, respectively, and the noise signal 511 and the lightwave signal 512 were outputted outside through the output amplifier 513. Although the read-out period to this exterior was called the horizontal scanning period, a reset switch Q6 is made into ON condition for the signal output line 1406 like an example 6 during this horizontal scanning period, and it continued impressing the electrical potential difference of the reset power source 1402 through reset switch Q6 andQ4 transistor. Moreover, the transfer switch Q1 was set as the electrical potential difference between high level and a low level. Consequently, the broadside overflow drain function in which overflow level is determined by the gate voltage of Q1 transistor was added, and the cross

talk to a contiguity pixel was made to mitigate.
[0071] For every period which transmits the signal from the pixel of a selection line to the signal are recording section 506 in the pixel of a non-choosing line as compared with an example 6, the transfer switch Q1 is turned off and an overflow drain stops a function. Image information was read for the drive approach of this example at the NTSC system rate. That is, the signal from the pixel of a selection line was transmitted to the signal are recording section 506 at about 10micro of level blanking periods sec, and the information on the signal are recording section 506 was read outside at about 50micro of horizontal scanning periods sec. Therefore, the period which stops the function of an overflow drain was about 17% of the whole period, and the most functioned as an overflow drain and it checked that sufficient effectiveness could be acquired.
[0072] according to drawing 13 -- switch QHn QHs A pair of switch Qn Qs The reset power source of a selection line, and the reset switch Q2 which it supposes a flow and un-flowing by making reset SW from a reset line into Hy Law just behind a reset power source, The transfer switch Q1 which transmits the charge of photo diode for a noise signal to the gate input terminal of MOS transistor Q3 before read-out glory signal read-out, The gate input voltage of MOS transistor Q3 which shows the electrical-potential-difference change by the charge corresponding to a lightwave signal after ON of the transfer switch Q1, Load switch Q4 bar which reverses with the reset switch Q4 which supplies a reset power source, and the reset switch Q4 which uses a constant current source as the load of MOS transistor Q3, and it supposes a flow and un-flowing, The signal output line in which the signal output voltage of the signal output line 1406 is furthermore shown is shown in timing.
[0073] The representative circuit schematic of the picture element part of this example is shown in [example 8] drawing 14 . MOS transistor Q5 for broadside overflow drains was separately formed to the pixel configuration of an example 7. The drain electrical potential difference of the case where the gate voltage of MOS transistor Q5 determines overflow level, and gate voltage = MOS transistor Q5 of MOS transistor Q5 = it carried out about the case where threshold voltage is adjusted so that it may change with VDD. Cross talk resistance almost equivalent to an example 7 could be checked, and it also checked that an example 7 was an effective means. In this example, although it is a broadside overflow drain by MOS transistor Q5, the overflow drain of end-fire array may be formed.
[0074] This example is explained using [example 9] drawing 15 . In

addition to the example 7, this example added Q4″. Like the example 7, ON, Q4', and Q4″ were turned off for Q4 during the horizontal scanning period, and it operated Q1 transistor as a broadside overflow drain. It flows Q4' and Q4″ through a change and MOS transistor Q3 as ON, using Q4 as off at the time of read-out, and enabled it to choose two kinds of approaches of reading, read-out and reversal amplifier read-out, as a source follower.

[0075] ON and Q4″ were set as OFF, the power source 1701 was set [Q4] as VDD for OFF and Q4', and, specifically, read-out as a source follower was performed like the example 1.

[0076] On the other hand, OFF and Q4″ were set to ON, the power source 1701 was set [Q4] to GND for OFF and Q4', and reversal amplifier read-out of an MOS mold was performed like the example 4. Since there is no selecting switch and Q3 transistor serves as a symmetric design to a power source and a signal output line, it is high, and various functions read-out of linearity becomes possible as an easy circuit is added. Specifically, square addition read-out by reversal amplifier read-out and bottom detection by source follower read-out were performed.

[0077] With this operation gestalt On an output signal line, reset supply voltage The load of the reset switch Q4 to supply or MOS transistor Q3 becoming -- a source follower -- a method -- reading -- a constant current source -- a load -- imposing -- a load -- a switch -- Q -- four -- ' -- a power source -- VDD -- supplying -- an electric power switch -- Q -- four -- ″ -- read-out -- a method -- a selecting switch -- an MOS transistor -- increasing -- as -- being visible -- although -- Since the increments in monopoly area were very few when comparing with the pixel of tens of thousands - 100,000 numbers, when comparing with deletion of a selecting switch, the big numerical aperture of a pixel could be secured and read-out was further made possible alternatively at read-out of a lightwave signal which removed the noise signal according to the situation.

[0078]

[Effect of the Invention] As explained above, according to this invention, the operating point of the input terminal of the signal amplifier of a picture element part, and by specifically changing the reset potential of an input terminal into predetermined potential, it is possible to perform selection and un-choosing, it becomes unnecessary to form the switch for the conventional read-out selection, and the following effectiveness is acquired. [of a read-out pixel]

[0079] The transistor count contained in a pixel can be reduced and a pixel can be contraction-ized. Moreover, even if it does not form a

selecting switch, the linearity of a signal amplifier is securable in the large electrical-potential-difference range. Furthermore, various functions read-out can be performed by adding the selecting switch of a setup of an easy circuit, the MOS transistor which specifically sets a signal output line as reset temporarily and a source follower circuit, and reversal amplifier.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a representative circuit schematic for 1-pixel and pixel 1 train of the operation gestalt of this invention.

[Drawing 2] It is the representative circuit schematic of 1 pixel of the example 1 of this invention.

[Drawing 3] It is a representative circuit schematic also including the read-out system of the example 1 of this invention.

[Drawing 4] It is cross-section structural drawing of the photo diode used for this invention, and the signal transfer section.

[Drawing 5] It is the property of the signal amplifier of the example 1 of this invention.

[Drawing 6] It is a pulse timing Fig. to the pixel transistor used for the example of this invention.

[Drawing 7] It is the representative circuit schematic of 1 pixel of the example 2 of this invention.

[Drawing 8] It is a representative circuit schematic also including the read-out system of the example 2 of this invention.

[Drawing 9] It is a representative circuit schematic also including the read-out system of the example 4 of this invention.

[Drawing 10] It is an easy representative circuit schematic also including the read-out system of the example 5 of this invention.

[Drawing 11] It is a pulse timing Fig. to the pixel transistor used for the example 6 of this invention.

[Drawing 12] It is an easy representative circuit schematic also including the read-out system of the example 7 of this invention.

[Drawing 13] It is a pulse timing Fig. to the pixel transistor and main transistors which were used for the example 7 of this invention.

[Drawing 14] It is the representative circuit schematic of 1 pixel of the example 8 of this invention.

[Drawing 15] It is an easy representative circuit schematic also including the read-out system of the example 9 of this invention.
[Drawing 16] It is the representative circuit schematic of 1 pixel of the conventional technique.
[Drawing 17] It is a representative circuit schematic also including the read-out system of the conventional technique.
[Description of Notations]
1,501 Reset power source
2,504 Reset switch line
3 Signal Amplifier
4,406 Signal output line
5 Photo Diode
6,505 Transfer switch line
7 Output Terminal of Signal Output Line
8,502 Power source
10,513 Output amplifier
13,511 Noise output
14,512 Signal output
15,506 Signal are recording section
16,507 Level shift register
18 18' Transfer switch to a common signal line
19, 19', 509,510 Common signal line
31, 32, 33, 34 Signal amplifier of a pixel
36 Load of Signal Amplifier
508 Perpendicular Shift Register